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# RADIOACTIVITY IN INDUSTRY PART I

(Florence E. Wall, New York, N.Y.)

*During World War I, some 200 women, who were employed by Radium Luminous Material Corp. in Orange, N.J., painstakingly applied paint containing radium to watch and instrument dials. Oblivious of the fate in store for them, the women pointed their brushes by moistening the bristles with their tongues and lips. During this period, Florence E. Wall worked as a chemist for the same company and, in this article, the first of a two part series, she describes some of her experiences.*

It was the summer of 1917. The draft was rapidly taking young men, and many plants were looking for women employees. Knowing that I had taken a course in radioactivity, George S. Willis, of Morristown, N.J., a consulting physician at the College of St. Elizabeth, offered me a job with the Radium Luminous Material Corp. in Orange, N.J., of which he was an officer. I had been teaching science and English in the high school in Suffern, N.Y., but willingly resigned and became the assistant to the company's president, Sabin von Sochocky, a physician and scientist. He was always referred to as "the doctor."

The company was engaged in extracting radium from carnotite ore and manufacturing and applying paint, made luminous with radium, to items such as watch and instrument dials, dashboards, indicators, and compasses. Busy with war contracts, the radium extraction plant operated day and night. It was housed in a three-story converted warehouse beside which was a new brick building where the paint was applied to the dials. To the rear was a railroad siding where a constant stream of cars unloaded carnotite ore and, from various factories throughout the country, boxes of equipment to be touched up with luminous paint. In the center of a yard was the electroscopic laboratory, a galvanized iron shed isolated from other build-

ings presumably as a protection against radioactive contamination. There, radioactivity of the products was measured.

My first assignment was analysis of the ore, a good grade of carnotite, a potassium uranovanadate ( $K_2O \cdot 2U_2O_3 \cdot V_2O_5 \cdot H_2O$ ) shipped from Placerville, Colo., and less expensive than the pitchblende used by the Curies who first isolated radium in 1898. Each carload lot had to be analyzed for uranium and vanadium as  $U_3O_8$  and  $V_2O_5$ .

When not busy with analyses, I liked to prowl around the plant, among the mixing vats and large filter presses used in processing the ore. One ton of ore was mixed with 60 tons of water and six tons of hot hydrochloric acid. This mixture was allowed to stand for a month. Then, in the crystallizing laboratory, large quantities of radium chloride solution from the plant progressed by stages from silica tubs, three feet in diameter and about a foot deep, into smaller evaporating dishes until, after conversion, the product appeared as a few crystals of radium bromide in a tiny dish,  $\frac{1}{2}$  inch in diameter. These crystals were then transferred to small glass tubes which were sealed and stored in heavy lead containers. The yield was 5 to 7 mg. of radium from a ton of ore.

The luminous paint, invented by the doctor, consisted of phosphorescent zinc sulfide with a little radium and an adhesive. The phosphorescent zinc sulfide was made by Isabel, one of the three girls working in the plant. She was not a chemist but an experienced commercial artist with an excellent knowledge of pigments, and each time she removed a batch from her grubby furnace, she would snap off the light and proudly survey the beautiful, brilliant greenish glow. The doctor himself ensured permanence of the glow by adding an infinitesimal amount of radium and an adhesive. When this mixture

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Containers showing recesses where tubes containing radium were inserted

dried, Hilda, another trusted employee, weighed the paint into tiny bottles.

A rigid accounting was kept of all materials. At that time, the market price of radium was \$115 a mg. or \$3.22 million an ounce. The following episode is an indication of how it was valued and also of the doctor's resourcefulness. On the day of my interviews I noticed a new pine floor in his private laboratory. He explained that a tube of radium salt had exploded and its contents had scattered over the front of a cabinet and the floor. "We could wash down the cabinet," he said, "but we had to take up and incinerate the whole floor." The recovery? 95%!

Also during this first interview, the doctor showed me his left index finger. The first phalanx appeared as though an animal had gnawed it. The doctor explained that when he realized radium had gone into his finger, he knew he could not tell anyone else what to do, so he hacked it off himself.

In the applications plant next door, 75 to 100 women were employed to apply the luminous paint to various items. Among them was a formidable timepiece, called the Ingersoll Dollar Watch, nick-named the "town clock." Using the luminous paint, the women busily painted hands and numerals on watches, pointing their delicate brushes by turning the bristles on their tongues and lips, as many artists used to do with water colors. Whether these women had been so instructed or whether this technique was their own idea has never been made clear.

About the middle of September, I was transferred to the electroscopical laboratory. The dismal iron shed was unlined, and the floor was of thin boards covered with a few pieces of oil cloth. There were broad shelves along two walls. During the day, light came from two windows; at night, from a single suspended bulb. The furniture consisted of a

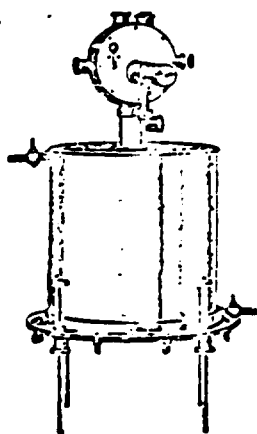
tan electrical stove, and several electroscopes of a model invented by the doctor and his colleague, Dr. Willis.

A considerable backlog of samples awaited determination. Each tiny tube contained a sample from a lot of ore and had to be tested electroscopically and the result recorded. The doctor prepared all my samples. Each was dissolved in water and sealed in a round, flat-bottomed flask which had to stand exactly 24 hours to allow a heavy gas, then called merely radium emanation, to collect in the flask. After this time, the accumulated gas was quickly pumped into the chamber of the electroscope and left undisturbed for three hours. A reading was then taken with the time of discharge calculated to the fraction of a second on a stopwatch (see margin next page). Each test, therefore, took 27 hours.

The doctor had confided that he did not wish to touch the electroscopes for fear of contaminating them with the radium he knew was in him. As a further precaution, he always sent a messenger ahead before making one of his rare visits. Because his presence could disturb a test, each electroscope had to be covered with a lead-impregnated protective cover. After the doctor left, everything he had touched had to be carefully wiped—perhaps a pencil, the ash tray, the back of the chair, and the door knobs—first with a cloth moistened with a barium chloride solution and then with one wet with dilute hydrochloric acid. The first cloth was supposed to pick up loose radium and the second, pick up both radium and barium.

I did this faithfully, even though the other chemists jeered good naturedly when they saw me swishing my rags. Also, I lumbered about in a lead-impregnated apron and always handled tubes of radium with ivory-tipped forceps. Anyway, I am still here, and many of my coworkers are not.

I began working on the accumulated samples in chronological order and for some weeks the electroscopical work went well. I planned the 27-hour tests so that I could go home for lunch during the three-hour waiting period. "Home" was a boarding house a mile from the plant, and with transportation lacking, this meant walking to the plant and back, twice each day. Soon my troubles began. The doctor suggested that as current samples became ready, they be run along with backlog samples. Also, the doctor often worked late at night and then did not appear until noon the next day, which meant that both



Sochocky-Willis electroscope

radium samples and paint... in a safe and Hilda could not fill the... es.

There were other inconveniences. If the doctor asked me to pick up a sample at five or six P.M., it meant I would have to be in the laboratory around the same time the next day to set up the electrosopes and also be there exactly three hours later to take the readings. This meant walking the mile home late at night—once between one and two A.M. Occasionally I had a Saturday afternoon off because I was booked to appear on Sunday, the hour to be announced.

I really enjoyed my work though. In addition to our own samples, I tested many other substances for alpha, beta, and gamma radiation—the company was interested in use of thorium instead of radium.

As winter approached (still cited in weather reports as the coldest of the century), the iron shed, partially warmed by the kerosine stove surmounted by a pan of water, became increasingly uncomfortable. In December, the electrosopes were moved into a vacant house, a few doors away, where only the kitchen and a small room over it were heated. In the meantime, the war brought increasing demands. The plants were running at full capacity and the number of dial painters had nearly doubled.

By Christmas, things had become quite difficult. We had the two holidays off, but on two of the days between I had to return to the plant at night. The weather was brutally cold. On New Year's day I cautiously took stock of my plight, and decided that perhaps the time had come to quit. It was a soul-searing decision to make, because as the only woman among the chemists, it might make me seem a sissy. On January 5, 1918, I left the radium company.

Afterward, I never saw anyone I knew while working there except the doctor's daughter who, as a little girl, came occasionally in a car with her mother, to pry her father loose from his laboratory.

In 1921, the company was merged with others to form the U.S. Radium Corp., and the doctor left. From bits of advertising now and then I learned that he was interested in peace-time applications of luminous paint and other completely different subjects such as colloidal sulfur and another product that might have been the first hormone cream. For the cream, however, he was a bit too early.

The doctor was a remarkable man, and stories about him have not done him justice. Born in 1882, in a small town in the then

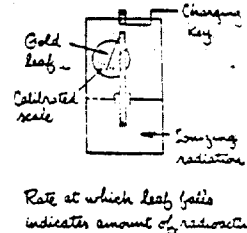
Austro-Hungarian Empire now in the Ukraine, he took his M.D. degree at the University of Moscow. But later, he became more interested in science than in medicine and took other degrees in Vienna, Berlin, and Prague. He met the Curies in Paris, and learned all there was to know about radium at that time. Also, he mastered five languages: English, French, German, Czech, and Russian.

On invitation to teach at a university, he came to the United States in 1906. But, dissatisfied with teaching, he practiced medicine for 10 years, and, in 1913, introduced his radium-enlivened paint. That same year, about 2000 illuminated watches were sold. The venture originally was intended to finance medical research, but the demand for luminous dials grew, and, in 1916, in collaboration with Dr. George S. Willis, he founded the Radium Luminous Material Corp. Incidentally, during World War I, about one man in every six in the army had an illuminated watch.

The tragic aftermath to this story began in 1923, when a dentist accidentally discovered disintegration in the jaw of a factory worker. A general alarm was sounded. Certain that this condition was caused by radiation, the authorities ordered the body of another factory worker who had died a few years earlier to be exhumed. This showed unmistakable signs of radium—the inside of the coffin was aglow with the soft luminescence of radium compounds. The next year, everyone available who had worked in the radium plant was called in for examination.

By 1925, the doctor himself admitted that he was loaded with radium, and worked with medical colleagues for three years in a study of his condition. He expended much energy and eloquence in explaining that his trouble was not necrosis of the bones, but aplastic anemia, a malady that affects the formation of red blood cells by the bone marrow. He practically lived on transfusions for months and finally died in November 1928. (To be continued)

*FLORENCE E. WALL received bachelor's degrees in both arts and education at the Academy and College of St. Elizabeth and a master's degree in health education at New York University. After many years in research on products and educational work on cosmetics and cosmetology, she taught cosmetology at several colleges. Author of six books on cosmetology and about 350 articles on a variety of subjects, she now specializes in technical writing and editorial work.*



# EARLY DAYS OF RADIOACTIVITY IN INDUSTRY PART I THE AFTERMATH EUGENIA KELLER MANAGING EDITOR

*Last month, Florence E. Wall described some of her experiences as a chemist for a radium plant during World War I. There, some 200 women, pointing their brushes with lips and tongue, applied, to watch and instrument dials, paint containing radium. This article describes some developments during subsequent years.*

In May 1925, *The New York Times* said: Five women have died and 10 others have been stricken with a new disease, believed to be radium necrosis, acquired while painting watch dials with a radium preparation in a factory (U.S. Radium Corp.) in Orange, N.J., according to F. L. Hoffman who read a paper before the American Medical Association. Hoffman said that by wetting their brushes with their lips, the women had introduced into their bodies minute quantities of radium. At first, the disease was thought to be phosphorus necrosis, but because phosphorus was not used in the paint, the only alternative was radium. Hoffman called for an expert investigation.

By the middle of June 1925, seven employees of the company, including the chief chemist, had died, all showing the same symptoms. At about the same time the U.S. Department of Labor ordered an inquiry into the causes of radium necrosis. The fact that the chief chemist did not paint dials or wet brushes with his tongue was noted. Perhaps the disease could be caused by inhalation of fumes.

That very little was known about radium is shown by the following events. Soon after the inquiry was ordered, the treasurer of U.S. Radium issued a statement saying that officials of the company did not believe that any deaths were caused by conditions at the factory. Radium in the infinitesimal quantities used in dial paint, he said, was helpful rather than injurious to the human system.

One day, another company official said in *The New York Times*: "No one has worked longer or with greater amounts of radium than has Mme. Curie. For over 25 years, she has toiled unceasingly in her laboratory and today she is not only much alive but reported recently in excellent health. Someday, this famous woman will die, either from old age or another cause, and then we will learn that she died a victim of radiation, a martyr of science." The official then went on to say that Leman, the chief chemist who had died, was not in robust health when he began with radium work. Then he proceeded to name several scientists working with radium who were healthy. (Here it is worth noting that Mme. Curie, after several years of ill-health, died in 1934 from leukemia said to have been induced by exposure to radioactivity.)

The day after this statement, periodic examinations of all persons handling radium was announced in *The New York Times* by Harrison S. Martland, medical examiner for Essex County in New Jersey. Sochocky, then vice president of the General Radium Corp., announced that he had perfected a method of diagnosing radium necrosis and described the symptoms: The effects are varied, sometimes affecting the gums, sometimes causing a rheumatic condition, anemia, debility, a condition similar to pyorrhea, and malaise. It is treacherous in its advance, sometimes becoming apparent only several years after handling the radium.

In December 1925, the seventh victim died, the cause of death being "chronic anemia of the pernicious regenerative type due to the injection of radioactive substances such as mesothorium (thorium-228), radium, and their decay products." The victim, aged 24, had worked for the company for six years until her health began to fail two years previously. Then in January of the following year, a young woman who had worked for the Ingersoll Watch factory died of radium poisoning. According to a medical report, her bones had slowly decalcified. She was the first from Ingersoll to die, but another girl had been seriously ill for a year.

Five women sued U.S. Radium for a total of \$1.25 million and the case attracted nationwide publicity. On April 27, 1928, *The New York Times* said: Five young women who are fighting in Chancery Court, in Newark, N.J., for the right to sue their employer, the U.S. Radium Corp. of Orange, N.J., listened again yesterday to the testimony of doctors who indicated there was little hope for

their recovery. The company invoked the statute of limitations. Because ill effects of the poison were not felt for several years after the complainants left the employ of the company and the unusual nature of the disease which, it was said, might manifest itself as much as 18 years later, the suit for damages should not be allowed to proceed.

Then the defense asked time to study evidence and the trial was adjourned until September of that year. However, the attorney for the victims petitioned to have the hearings resumed the next month on the basis that the women might not live until September. In its opinion, the court said: The statute of limitations did not run from the time the girls took this poison into their systems, but from the time of injury. For the injury they received yesterday from radioactive material lingering in their bodies, they are entitled to legal action for the next two years.

At this point the defense and prosecution completely reversed their positions. After having pressed for earlier hearings, the women's attorney then asked for a delay, and the company's attorneys pressed for earlier hearings. Judge Clarke of the Circuit Court then figuratively knocked heads together and ordered the attorneys on both sides to confer. When the attorneys failed to reach an agreement, the judge ordered that all five cases be tried in June. Then acting as a private citizen he sought a compromise, saying, "I was impelled simply by humanitarian motives in calling the conference after reading in the newspapers of the plight of these women. My only interest in this matter is seeing them receive sufficient compensation to make them happy for the rest of their lives." A compromise was reached on June 4, 1928. Each of the five women was given \$10,000 in cash, and an income of \$50 a month plus all medical expenses for the rest of their lives.

All of the women expressed a desire to go away and rest. Four were satisfied with the settlement but the fifth said she doubted her ability to care for her two children, eight and five years old, on the income she would receive. At this time another woman, 22, claimed to have been poisoned. Beginning in 1921 she had worked for U.S. Radium for 18 months.

The first of the five doomed women died in October of 1929 and the next month another woman who had worked for U.S. Radium claimed that her six-year-old son was poisoned—he had the same symptoms but to a

lesser degree, and was himself radioactive. She had filed a \$200,000 suit against U.S. Radium. Another woman filed suit—her two sons, six and two years old, were said to be radioactive. Martland, by then considered an authority on radium poisoning, said that the disease could be contracted before birth but he doubted that the malady thus incurred would ever become malignant.

The next month another suit for \$250,000 was filed by another worker on behalf of herself and four children born since she had worked at the plant 12 years earlier. Part of her jawbone had been removed because of radiation damage. Still another suit was filed by another worker, whose husband claimed that she had been disabled for life.

On October 28, 1933, the twenty-second victim died. She was the third to die of the original five who had attracted nationwide publicity, and she had been ill for about five years. The second had died in February of the same year. In March of the following year another suit was filed, this one for \$333,000. The plaintiff said she moistened her brushes on instructions from her supervisor.

Cases of death caused by exposure to radium continued to be reported. In 1934, Miss Wall was called as a witness in another type of suit for a death caused not by radium poisoning itself, but by cancer induced by radium. By 1959, 44 victims had been counted, and the number of deaths caused by but not traced to radium is unknown. At one time radium was used in a tonic, called Radithor, probably because during the first stages of poisoning, radium produces an appearance and feeling of increased health.

The story of those exposed to radium isn't closed. In 1958, the Scientific Committee of the United Nations issued a report on the effects of radiation from sources such as fallout or contamination of the waterways. This report immediately caused concern and the dial painters were figuratively exhumed again. The U.S. Atomic Energy Commission said that evidence available was inconclusive and urged that research be continued. One program being carried out at M.I.T. is concerned with current radioactive contamination from all sources. Miss Wall, although never a dial painter, was called and examined for accumulated radioactivity—that persisting from her work with radium plus that acquired from other sources such as fallout. Fortunately no such accumulative effect was found. Studies continue, and the menace of radiation is still with us. (*The last of a two-part article*)